

# Angle-Resolved Two-Dimensional Mapping of Electron Emission Following Cl 2p Excitations in the HCl Molecule

E. Kukk,<sup>1,2</sup> A. A. Wills,<sup>1</sup> B. Langer,<sup>3</sup> J. D. Bozek,<sup>2</sup> O. Nayandin,<sup>1</sup> M. Alshehri,<sup>1</sup> A. Farhat,<sup>1</sup> D. Cubaynes<sup>4</sup> and N. Berrah<sup>1</sup>

<sup>1</sup>Physics Department, Western Michigan University, Kalamazoo, MI 49004

<sup>2</sup>Lawrence Berkeley National Laboratory, Advanced Light Source, University of California, Berkeley, CA 94720.

<sup>3</sup>Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, D-14195, Berlin, Germany.

<sup>4</sup>Laboratoire de Spectroscopy Atomique et Ionique, URA 775, CNRS, Université Paris Sud, 91405 Orsay, France.

## INTRODUCTION

Inner-shell processes in small molecules have been studied with growing interest during recent years. Rapid improvements in experimental techniques have revealed new details in Auger and photoelectron spectra such as anisotropy of electron emission [1-3], molecular field splitting [4] and post-collision interaction [5]. However, these studies have been performed at only a few selected photon energies.

## RESULTS AND DISCUSSIONS

We have measured a complete angle-resolved two-dimensional experimental picture of electron emission from a diatomic molecule over the pre-edge structure and into the continuum of a core ionization threshold. The extensive set of data demonstrates many phenomena associated with core excitation and ionization. They are described in Kukk et al. [6] along with the experimental method. Briefly, we have measured Auger and valence photoelectron spectra of HCl over 14 eV wide photon energy range across the Cl 2p ionization thresholds as shown in Fig.1. Auger decay spectra of dissociative core-excited states were observed to change with photon energy, reflecting a change in the rate of dissociation. Auger electron spectra at the first Rydberg states were analyzed and the evolution of the resonant Auger to the normal Auger decay, distorted by post-collision interaction, was examined. Valence photoionization channels were shown to resonate strongly at the photon energies of the core-to-Rydberg excitations. We derived the angular distributions of the photo- and Auger electron lines and observed strong fluctuations of the asymmetry parameter  $\beta$  values of the  $2\pi$  photoline at some Rydberg resonances. However, the anisotropy of the Auger decay at the  $\sigma^*$  and that of Rydberg excitations was found to be different, with the latter showing uniformly negative  $\beta$  values.

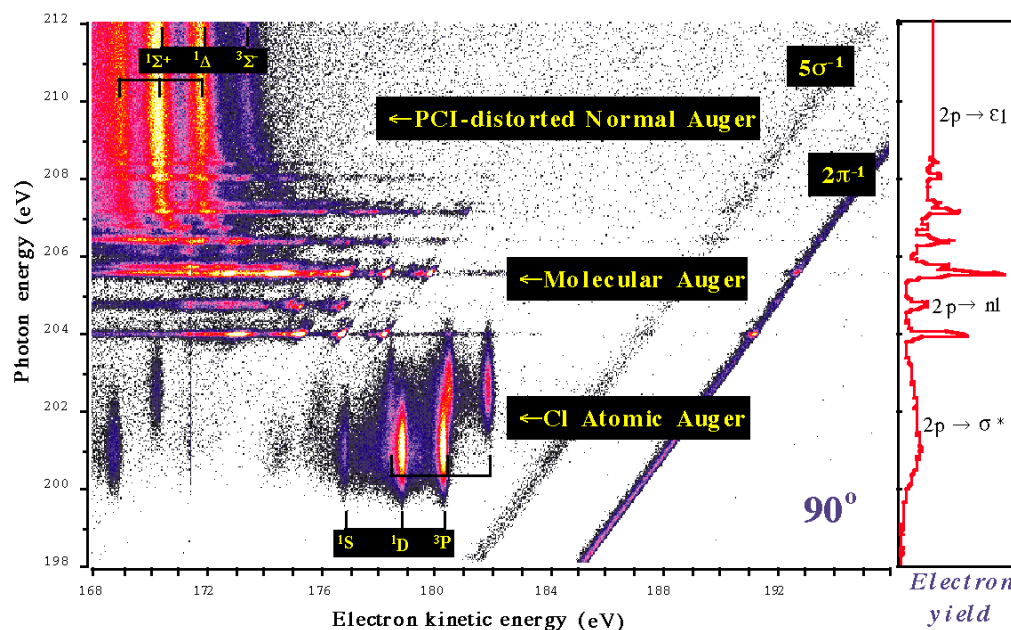


Fig.1. Two-dimensional (2D) map of electron emission from the HCl molecule across the Cl 2p ionization threshold, taken at 90° relative to the polarization plane. The total electron and partial 2π photoelectron yields are shown on the right.

## ACKNOWLEDGMENTS

This work was supported by the US Department of Energy, Office of Basic Energy Science, Division of Chemical Science under contract No. DE-FG02-95ER14299.

## REFERENCES

1. U. Becker, R. Holzel, H. G. Kerkhoff, B. Langer, D. Szostak, and R. Wehlitz, Phys. Rev. Lett. **56**, 1455 (1986)
2. O. Hemmers, F. Heiser, J. Eiben, R. Wehlitz, and U. Becker, Phys. Rev. Lett. **71**, 987 (1993).
3. U. Hergerhahn and U. Becker, J. Electron Spectrosc. **72**, 243 (1995).
4. H. Aksela, E. Kukk, S. Aksela, O. P. Sairanen, A. Kivimaki, E. Nommiste, A. Ausmees, S. J. Osborne, and S. Svensson, J. Phys. B. **28**, 4259 (1995).
5. M. Neeb, M. Biermann and W. Eberhardt, J. Electron Spectrosc. **69**, 239 (1994).
6. E. Kukk, A. A. Wills, N. Berrah, B. Langer, J. D. Bozek, O. Nayandin, M. Alsherhi, A. Farhat, and D. Cubaynes, Phys. Rev. A **57** R1485 (1998).

Principal investigator: Nora Berrah, Western Michigan University. Email: berrah@wmich.edu.  
Telephone: (616) 387-4955.